Final Report

Treatability Study: Air Sparging/Soil Vapor Extraction System

Amphenol Franklin Power Products
Franklin, Indiana

May 1999

O'BRIEN & GERE
ENGINEERS, INC.

3729/21493

REPORT

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1. Introduction

This report presents the results of the air sparging/soil vapor extraction (AS/SVE) pilot study conducted at Amphenol/Franklin Power Products facility in Franklin, Indiana. The pilot study was conducted in compliance with Section VIII. F and Attachment A, Task III of the Administrative Order on Consent U.S. EPA I.D. # IND 044 587 848. This report also presents basis of design considerations for a for a full scale AS/SVE system, based on the pilot study results.

1.1. Site background

The Amphenol/Franklin Power Products facility covers an area of approximately 15 acres. The property is bounded on the east by Hurricane Road, on the south by Hamilton Street, on the north by an abandoned rail line, and on the west and northwest by a Farm Bureau Co-Op facility and Arvin Industries, respectively. To the south, southeast, and southwest, the land use is primarily residential. A site location map is included as Figure 1.

The main structure on the site is a 46,000 square foot building formerly used in the manufacture and distribution of electrical components. This building was built in 1961 by Dage Electric, Inc. for the manufacture of electric connectors. The operation was acquired in 1963 by Bendix Corporation for its Bendix Connector Operations plant. Processes included electroplating, machining, assembling and storing manufactured components. From 1961 to 1981, wastewater from plating operations at the facility was discharged directly into a municipal sanitary sewer. In 1981, a wastewater pretreatment system was installed in a separate building for treatment of cyanide and chromium bearing wastewater from the plating room. New wastewater lines were installed from the plating room to the pretreatment building, with the effluent from the pretreatment plant routed to a sanitary sewer manhole just south of the main manufacturing building. In 1983, the Bendix Corporation was acquired by Allied Corporation and merged with its Amphenol Products Division. As a result of consolidation efforts, manufacturing at the Franklin facility ceased in September 1983 and the plant was closed at that time.

Closure of RCRA units began in February 1984. In 1986, Amphenol Products Division became the Amphenol Corporation, and in 1987 it was sold and became a wholly owned subsidiary of LPL Investment Group, Inc. Amphenol sold the facility to Franklin Power Products, Inc. on June 15, 1989.

A hydrogeologic investigation of the facility was initiated in February 1984 by Allied Corporation concurrent with plant closure activities, and in anticipation of the sale of the property. The investigation entailed the collection and analysis of soil samples and groundwater samples for volatile and semi-volatile organic compounds, pesticides/PCBs, EP TOX metals and cyanide. A total of 10 volatile organic compounds (VOCs) were detected in ground water. In particular, elevated concentrations of tetrachloroethene (PCE) and trichloroethene (TCE) were detected in wells adjacent to the main facility building, particularly along the southwest corner adjacent to the plating room. The sanitary sewer line and the soils beneath the plating room were also investigated.

A second hydrogeologic investigation began in February 1985 to develop a more comprehensive characterization of ground water flow, ground water quality and contaminant transport on and near the property. The investigation included the collection of ground water samples from existing monitoring wells, sampling of the storm sewer discharge, and sampling of the Hurricane Creek surface water. A variety of VOCs were detected in ground water samples, storm sewer discharge samples, and Hurricane Creek surface water samples. The greatest level of contaminants appeared to be concentrated in areas south of the former plating room. Six additional monitoring wells were installed and sampled. Analytical results obtained from the ground water samples indicated that the storm drain along the south boundary was acting as a partial ground water intercept. Additionally, 27 soil borings were installed along the west and south sides of the former plating room. Minimal contaminant concentrations were detected in the samples obtained from the soil borings. In each sample, total VOC content was less than 3 ppm.

In September of 1985, a ground water monitoring plan was submitted to the Indiana State Board of Health and implemented in February 1986. Results obtained during the ground water monitoring program were generally similar to the results obtained during the 1985 hydrogeologic investigation.

The following closure and corrective measures activities were conducted at the Amphenol facility in response to the previously described investigations:

- Removed and disposed of plating room floor and soil beneath the floor to a depth of nine feet. The excavation was treated with sodium hydroxide. Clean backfill and a new concrete floor were provided;

- Disconnected and plugged the old sanitary sewer line and replaced it with a new line offset 35 feet east of the old one;

- Drained and treated fluids from the wastewater treatment system, the plating room tanks and other areas in the plating room;

- Drained and treated liquid from the underground cyanide overflow tank, and capped the pipes at the discharge end; and

- Removed twelve previously installed ground water monitoring wells and grouted the boreholes to the surface.

In 1990, an Administrative Order on Consent was signed by respondents Franklin Power Products and Amphenol Corporation. Respondents were responsible for conducting a Resource Conservation and Recovery Act Facility Investigation (RFI). RFI field activities began in January 1992 and work was performed in accordance with the approved RFI Work Plan. RFI investigations were performed from 1992 through 1994.

RFI investigations indicated that past practices at the former Amphenol site involved the disposal of chlorinated solvents to the sanitary sewer. Leaking joints in the vitrified clay sanitary sewer, and a failure of the sewer where it crosses over a 72-inch storm sewer line caused chlorinated solvents to be released into the environment. The primary area of concern is proximate to the sanitary sewer line failure. During periods of high ground water levels, the storm sewer intersects the ground water table allowing VOCs to enter.

Based on the results of the RFI and with concurrence of the USEPA, respondents initiated the design and implementation of an interim corrective measure (ICM) in August 1994. The purpose of the ICM was to remediate ground water using a pump-and-treat system, and to depress the surface water to a level below the storm sewer thereby limiting the release of VOC constituents to Hurricane Creek. The respondents are also responsible for conducting a Corrective Measures Study (CMS). The purpose of the CMS was to evaluate applicable and appropriate remedial technologies based on the findings of the RFI and site characteristics. The corrective measure presented in the CMS included institutional controls, on and off-site ground water monitoring for VOCs, and monitoring of VOCs in on-site soil. Data collected from the monitoring wells will allow more effective observation of the level and fate of VOCs in soil and ground water and will allow monitoring of effects of continued operation of the existing extraction wells and air stripper (ICM). Additionally, the CMS recommended the implementation of a focused, on-site AS/SVE pilot test program to evaluate whether this technology was suitable for the site.

1.2. Purpose and objective

The purpose of the AS/SVE pilot study was to evaluate the feasibility of this technology to supplement the existing ground water recovery system and enhance the removal of VOCs from ground water in the vicinity of the storm sewer. The objective of this pilot study was to identify an effective radius of influence and basis of design parameters that may be used to assist in the design of a full scale AS/SVE system.

2. Air Sparging/Soil Vapor Extraction Pilot Study

The pilot study was completed to evaluate the application of AS and SVE at the subject site. The results of this effort were used to develop the conceptual preliminary design.

The pilot program consisted of installation of pilot study wells and field testing of AS and SVE systems. Below is a summary of the activities performed and the results obtained.

2.1. Pilot study equipment

To conduct the study, a temporary AS/SVE pilot system was installed on-site. The system consisted of two AS injection wells (ASI-1 and ASI-2), two monitoring locations (MON-1 and MON-2), and an SVE well (SVE-1). The location and configurations of the AS/SVE well system are shown on Figures 3 and 4, respectively.

ASI-1 and ASI-2 were installed to the bottom of the silty sand unit, located approximately 20 feet below ground surface (bgs). The injection wells were constructed of 2-inch ID PVC having 2 ft sections of 0.01-inch slot screens at the bottom. The monitoring locations are approximately 5 ft and 8 ft away from ASI-1. Each monitoring location consists of two 1 ¼-inch ID PVC monitoring points fitted with a 2 ft bottom well screen. One monitoring point was installed in the saturated zone to a depth of approximately 18 ft bgs, and one point was installed in the unsaturated zone to a depth of approximately 8 ft bgs. A 3 ft thick bentonite plug was installed between the lower and upper monitoring points in each borehole to minimize interference between the lower and upper monitoring points. In addition to the MON-1 and MON-2 monitoring points, existing monitoring well MW-22, located approximately 10 ft from ASI-1, was also utilized during the study. AS injection wells and monitoring well locations are presented on Figure 3.

The soil vapor extraction well, SVE-1, was installed to a depth of 8 ft, approximating the unsaturated portion of the silty sand unit (beneath the glacial till unit). SVE-1 was constructed of 2-inch ID PVC with a 2 ft section of 0.01-inch slot screen at the bottom. Monitoring points MON-1 and MON-2, described above, also served as monitoring points for the SVE tests.

The AS equipment provided on the temporary, trailer mounted AS/SVE system included a carbon vane compressor with up stream/down stream pressure gauges, flow control valve and flow meter. The SVE equipment included a regenerative blower with an upstream liquid separator, and suction/discharge piping. The piping included a vacuum gauge, flow control valve, and flow meter.

Field monitoring equipment included pressure and temperature gages, a water level probe, dissolved oxygen (DO) meter, a photoionization detector (PID), helium detector, velocity meter (velometer), temperature gauge, and Draeger tubes.

2.2. Pilot study description

After baseline testing, the pilot study was conducted in three phases as summarized on Table 1. The first phase was the AS test, the second phase was the SVE test, and the third phase was the combined AS/SVE test.

The Phase I AS test was conducted to evaluate the radius of influence of injected air into the shallow ground water at the site. Compressed air injected into the saturated subsurface forms air bubbles which travel horizontally and vertically away from the injection point. To monitor the distances the air bubbles travel from the point of injection, a helium tracer was added.

The AS pilot study was initially run at a flow rate of approximately 6 cfm, at a pressure of 3 pounds per square inch-gauge (psig), with a helium flow rate of 10 liters per minute. Due to minimal increase in DO concentrations at monitoring locations, the AS flow rate was increased to 8 CFM after 7 hours. The flow rate was then increased to approximately 10 CFM after an additional 21 hours and to 12 CFM after an additional 20 hours.

During the AS pilot study, dissolved oxygen, helium, and ground water levels were measured at monitoring points MON-1D, MON-2D and MW-22. In addition to the evaluation of the radius of influence, the response of VOC concentrations to AS was also evaluated. VOC concentrations in ground water were monitored at MON-1 and MON-2, prior to, during, and after performance of the pilot study. Sampling frequency is summarized in Table 1. Sampling data is included in Appendix A.

The Phase II SVE test was conducted to evaluate the radius of influence of the extraction wells in the vadose zone at the site.

The SVE test was initially performed at 50 CFM at approximately 20 inches of water column vacuum (in. H_2O). Based on the low vapor concentrations and vadose zone pressure, the flow rate was increased to 100 CFM at 53 in. H_2O after approximately 1 hour. The flow rate was momentarily increased to 120 CFM at 64 in. H_2O after approximately 13 hours. Sediment was recovered from the SVE well at 120 CFM so the flow rate was reduced to 100 CFM for the duration of the test. The vacuum at the SVE well stabilized at approximately 48 in. H_2O.

The application of a negative pressure to the vadose zone resulted in extraction of VOCs present in pore spaces disrupting the equilibrium between VOCs on the soil and in the soil vapor. Air extracted during SVE test was sampled for VOCs using TCE and PCE specific Draeger tubes temporarily installed in the discharge stack of the SVE system. In addition, pressures in monitoring points (MON-1S and MON-2S) were measured to evaluate responses to varying extraction rates and partial vacuum on SVE-1. Sampling frequencies are summarized in Table 1. Sampling data is included in Appendix A.

In addition to operating both AS and SVE systems separately, a Phase III - combined AS/SVE test was conducted. The purpose of the combined test was to evaluate the effectiveness of SVE capture of AS generated soil gas. During this phase of the pilot study, air was injected into the saturated zone via ASI-1 and ASI-2, while air was extracted from the unsaturated vadose zone via SVE-1. The combined phase of the pilot study lasted for seven days. During this phase of the pilot study, ASI-1 was operated at 6 CFM and 10 CFM, ASI-2 was operated at 6 CFM, and SVE-1 was operated at 75 CFM. Sampling frequencies are summarized in Table 1. Sampling data is included in Appendix A.

2.3. Pilot study results

Phase I - AS test. The radius of influence from AS was evaluated by monitoring increases in the concentration of DO in groundwater in monitoring wells/points. A DO concentration increase above background generally indicates that the ground water point is within the area of influence of the AS well. An increase in the vadose zone VOC concentrations in monitoring wells provides an indication that organic compounds are being stripped from the ground water and transferred to the vadose zone. An increase in vadose zone pressure in monitoring wells provides an indication of the zone of influence of sparged air after it leaves the saturated zone.

DO concentrations taken before the start of the AS test indicated background concentrations of approximately 1 to 5 milligrams per liter (mg/L). The DO concentrations in MON-2D and MW-22 were extremely variable throughout the test. A slight but a general increase was observed in MON-1D. Based on this information, the AS radius of influence was determined to be approximately 5 ft. The radius of influence from an AS well is commonly in the range of 1 to 1.5 times the depth of the top of the sparge point below the ground water surface. Since the baseline water level in the injection well was approximately 4 ft above the top of the screened section, the radius of influence found at this site is within the expected range of approximately 4 to 6 ft.

Helium concentrations taken before the start of the air sparging test indicated no background trace of helium. Helium concentrations increased and decreased, consistent with changes in the amount of helium injected into the air stream, for MON-1S, MON-2S, and MW-22. The other monitoring wells did not indicate significant changes over background concentrations during the AS test.

Increases in the VOC concentrations at all of the monitoring locations with screened sections in the vadose zone indicate that organic compounds were being stripped from the groundwater and transferred to the vadose zone. Increases in the pressure in those monitoring wells indicated that sparge air migration was occurring in the vadose zone.

Phase II - SVE test. The vacuum measurements recorded at MON-1S and MON-2S were used to evaluate the radius of influence from the SVE pilot study. A vacuum less than - 0.01 inches of water (in. of H_20) has been used at other sites to define the effective radius of influence, or the distance at which sufficient air flow is believed to exist for remediation of the vadose zone. Vacuums were observed at MON-2S and MW-22 of approximately

-0.80 and -0.08 in. H_2O, respectively. Vacuum was not observed at MON-1S, which is approximately 8 feet from SVE-1. The reason for a lack of vacuum at MON-1S is unknown. However, it is conjectured that the effective radius of influence may be somewhat linear along the 72-inch storm sewer. The radius of influence along the sewer line is unknown since only one well was installed along the sewer backfill. The effective radius of influence appeared to extend into the natural formation for a distance of 15 to 20 ft.

The effective radius of influence was observed to be less than expected at the SVE flow rate. This may be due to the proximity of the SVE well to the sewer line.

Phase III - AS/SVE test. During the AS/SVE phase of the pilot study, pressures were recorded at MON-1S and MW-22 of approximately 0.01 and 0.23 in. H_2O, respectively. Positive pressure indicates that the extraction well is not causing a vacuum in the vadose zone and therefore is not effectively capturing the sparged air.

Vapor sample results. The concentrations of TCE and PCE in the exhaust from the SVE blower were monitored periodically with Draeger tubes throughout the SVE and AS/SVE phase of the pilot study. The concentrations of TCE in the blower exhaust were below detection limits throughout the test. The concentrations of PCE in the blower exhaust varied from below detection limits to approximately 10 parts per million (ppm), with an average of approximately 2 ppm. A PID was also used to quantitatively monitor VOCs from the blower exhaust and the monitoring locations. The concentration of VOCs in the blower exhaust varied from approximately 0.7 to 18 ppm, with an average resultant of approximately 2 ppm. The concentrations of VOCs at the monitoring wells varied from non-detectable concentrations to approximately 73 ppm at MW-22 with the PID. Using PCE Draeger tube measurement data and the formula provided in Appendix B, the average removal rate of PCE during the pilot study was approximately 0.005 pounds per hour.

2.4. Feasibility evaluation

The design of a full scale AS/SVE system is contingent on results obtained during the pilot study. To evaluate the feasibility of this technology for the subject site, it will be assumed that individual injection points will exhibit a 5 ft radius of influence and extraction points will exhibit an approximately 20 ft radius of influence.

Based on the assumed radius of influences, a full scale AS/SVE system would consist of 80 injection wells and 9 extraction wells distributed across an area of approximately 200 ft by 40 ft. The approximate size and location of the treatment area is presented on Figure 2. A total of 89 wells would need to be installed in order to achieve overlapping cones of influence across the treatment area. Due to the large number of wells required to effectively cover the treatment area, this technology may not be feasible for this site.

2.5. Conclusions

As stated above, the results of the pilot study indicated that SVE removed PCE from the vadose zone at a rate of approximately 0.005 pounds per hour. With new well upgrades to the on-site ground water recovery system, installed as part the ICM described above, PCE detected in influent is approximately 1600 parts per billion and the average pumping rate of the four recovery wells is approximately 26 gallons per minute. Analytical results of the effluent data show that treated water discharged from the ground water recovery system is clean. The ground water recovery system effectively removes PCE from the ground water at a rate of approximately 0.02 pounds per hour. Due to the large number of wells required for the AS/SVE system and the relatively low expected PCE recovery rate, the design and installation of a full scale system is not recommended. Further evaluation and possible enhancement of the upgraded on-site ground water recovery system is recommended as a feasible remedial alternative to the AS/SVE system.

References

Gabriel, William J, CPG (O'Brien & Gere). Letter to Samuel Waldo (Amphenol/Franklin Power Products) Re: AS/SVE pilot study plan. February 25, 1999.

Hanford, C. Todd (Burns & McDonnell Waste Consultants, Inc.). Letter to Judy Rank (O'Brien & Gere) Re: Summary of pilot testing activities. April 15, 1999.

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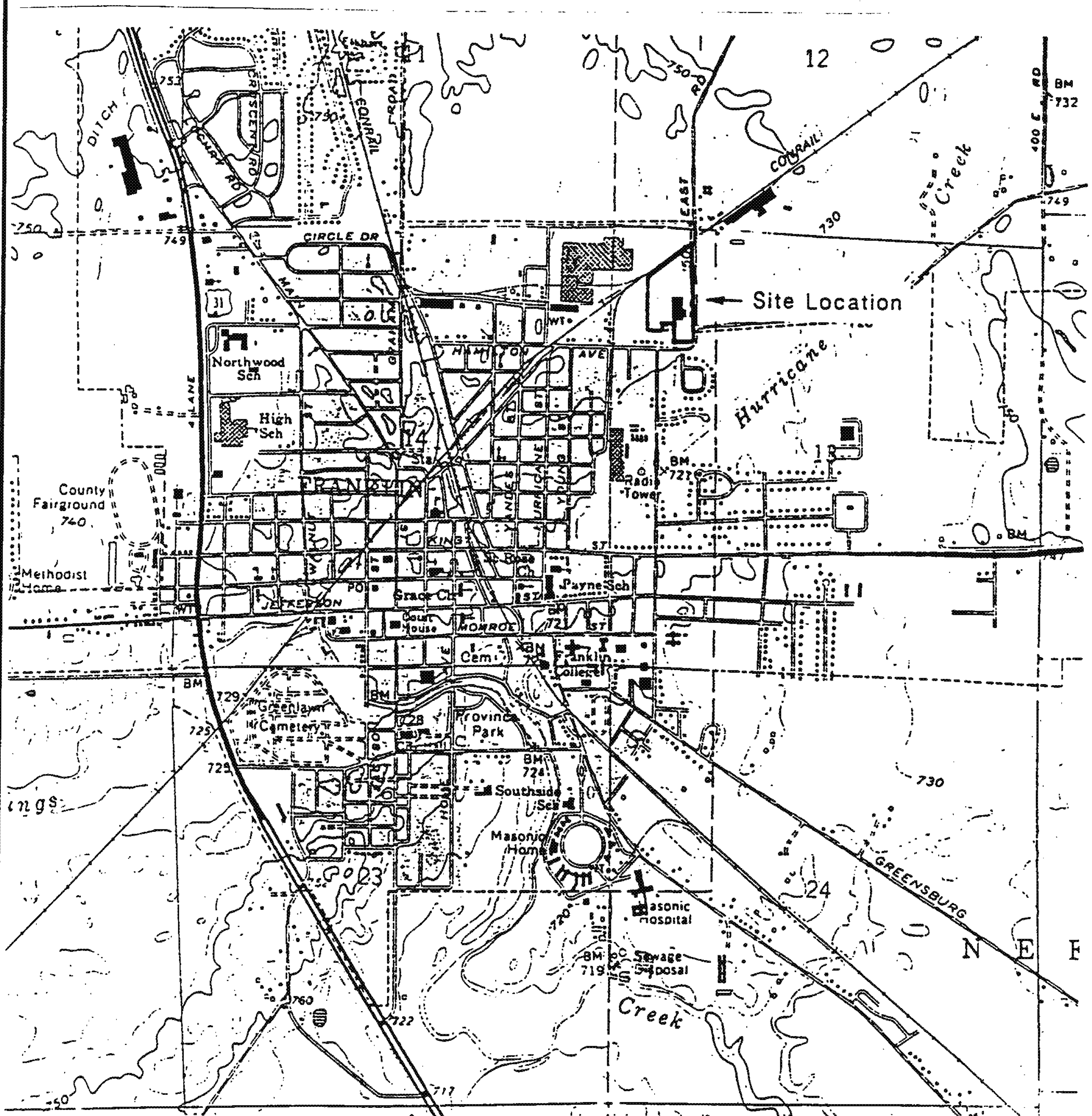
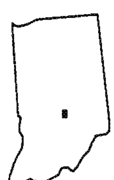
FIGURE 1



SOURCE: ADAPTED FROM U.S.G.S. FRANKLIN, INDIANA 7.5' TOPOGRAPHIC QUAD.



STATE LOCATION MAP

AMPHENOL CORP.
FRANKLIN POWER PRODUCTS FACILITY
SITE LOCATION MAP

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

SCALE: 1:24000

PLOT DATE: 4/27/99

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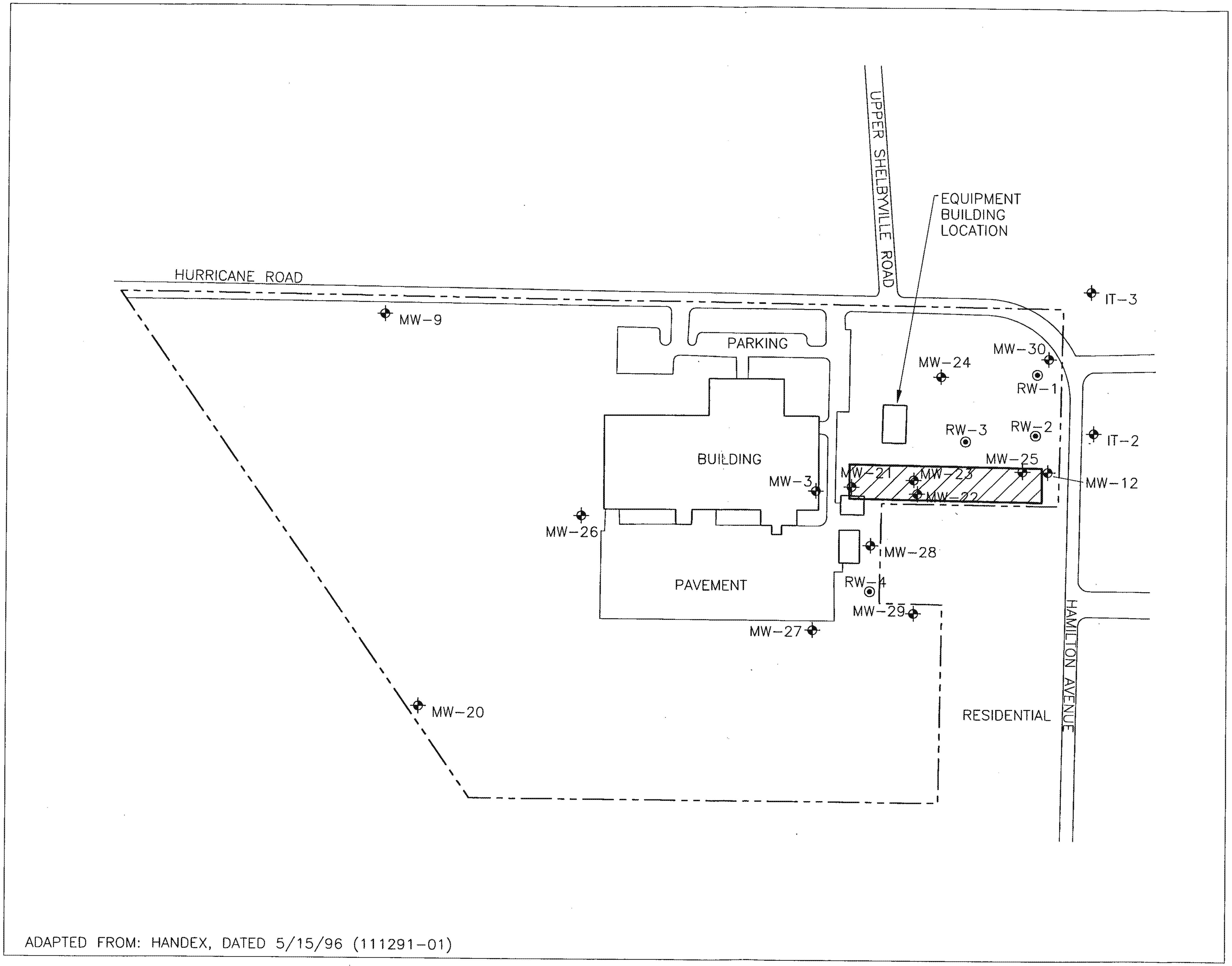

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FIGURE 2

LEGEND

PROPERTY LINE

MONITORING WELL LOCATION

RECOVERY WELL LOCATION

**AMPHENOL CORP.
FRANKLIN POWER PRODUCTS
FACILITY**

SITE MAP

1"=100' 100 0 100

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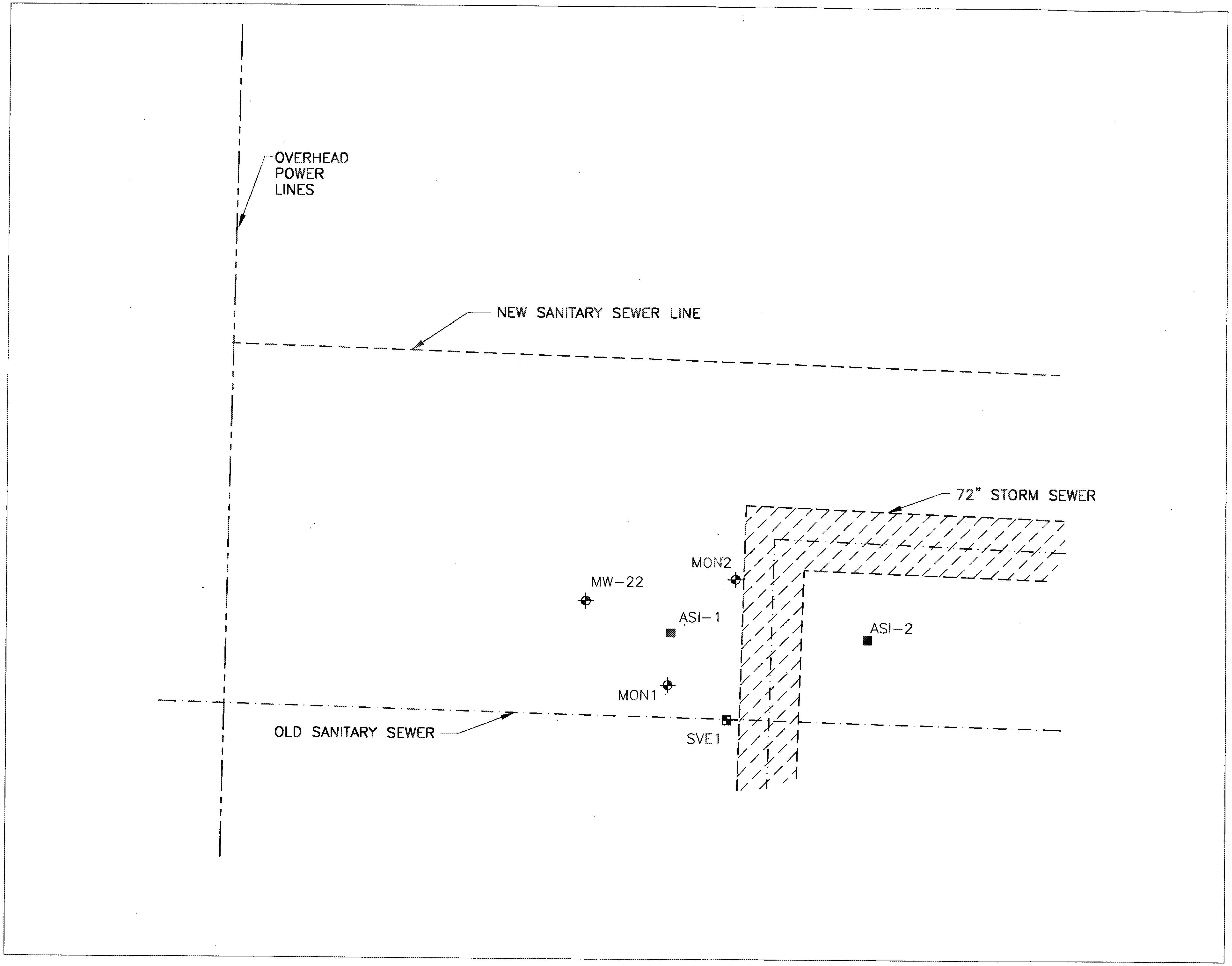

FIGURE 3

LEGEND

- APPROXIMATE MONITORING WELL LOCATION
- APPROXIMATE ASI LOCATION
- APPROXIMATE SVE LOCATION

AMPHENOL CORP.
FRANKLIN POWER PRODUCTS FACILITY

AIR SPARGING/ SOIL VAPOR EXTRACTION WELL LOCATIONS

1"=10'   10   0   10

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PLOT DATE: 4/27/99

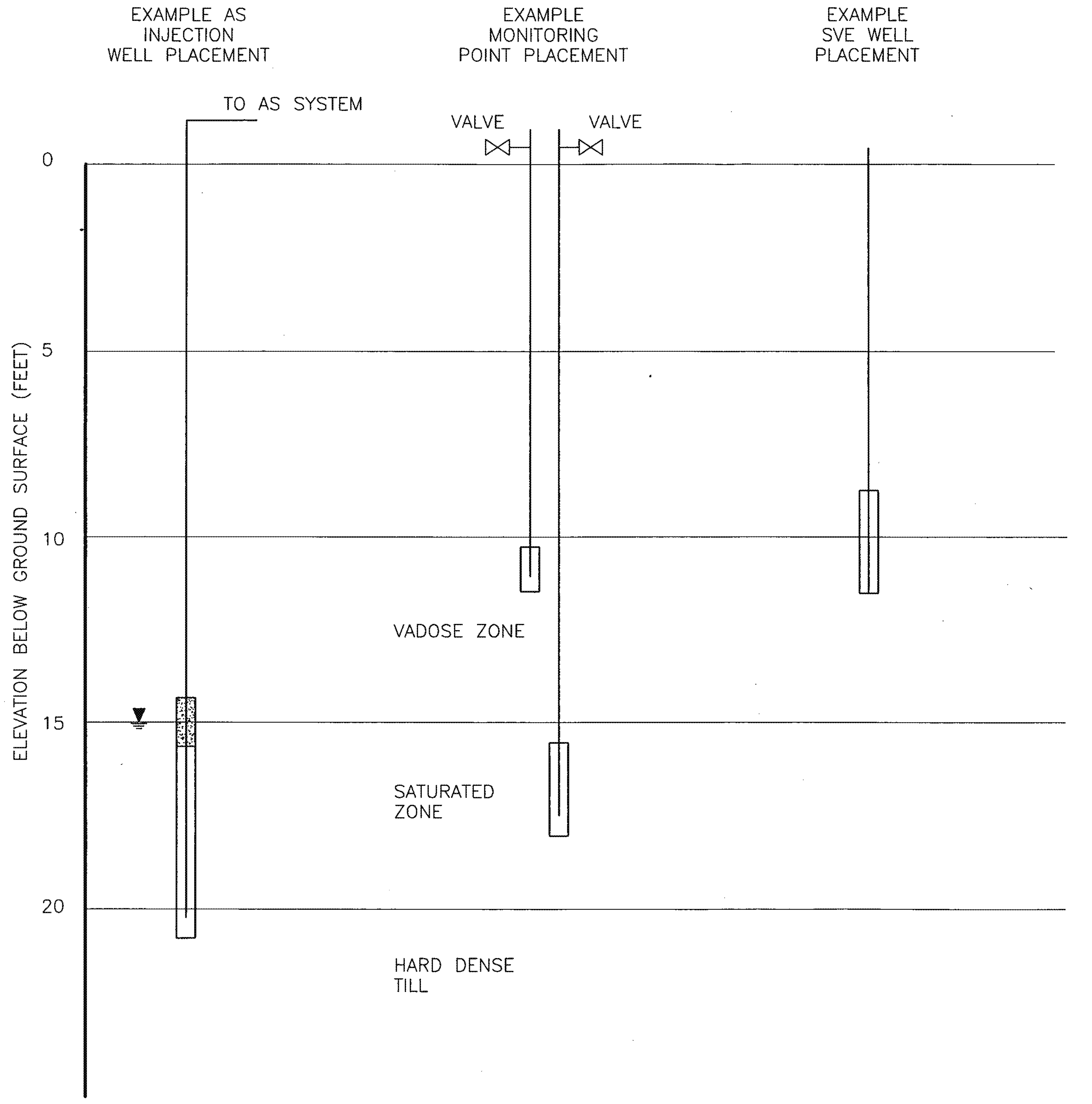

FIGURE 4

AMPHENOL CORP.
FRANKLIN POWER PRODUCTS FACILITY

PILOT STUDY WELL SCHEMATIC

NOT TO SCALE

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Table 1. *Sampling and monitoring activities*

Phase	Media	Sample frequency	Location	Parameter (Method/instrument)
Baseline testing (prior to initiation of each of the 3 pilot tests)	ground water	Twice a day for one day	ASI-1, ASI-2, MON-1D, MON-2D, MW-22	static water level (probe) DO (DO meter) VOCs (PID)
	ground water	One time before sparge test	MON-1D, MON-2D	VOCS (USEPA 8021)
	soil gas	Twice a day for one day	MON-1S, MON-2S, SVE well	VOCs (PID) helium (helium meter)
During all test operations	air	Continuous*	breathing zone (4 to 7 ft above ground in vicinity of monitoring points and SVE system)	VOCs (PID)
Phase 1: air sparging test Test duration: 3 days	ground water	1 hr into test, 3 hrs into test, 6 hrs into test; every 6 hours thereafter*	MON-1D, MON-2D, MW-22	DO (DO meter) helium (air within wells) static water level (probe)
	ground water	during air sparge test	MON-1D MON-2D	VOCS (USEPA 8021)
	soil gas	1 hr into test, 3 hrs into test, 6 hrs into test; every 6 hours thereafter*	MON-1S, MON-2S	helium (helium meter) VOCs (PID) vapor pressure
	air flow to AS well	1 hr into test, 3 hrs into test, 6 hrs into test; every 6 hours thereafter*	ASI-1	air flow helium flow
	air flow		Blower/ compressor discharge	air pressure
Phase 2: soil vapor extraction test Test duration: 3 days	soil gas	30 min into test, 1 hr into test, 3 hrs into test, 6 hrs into test; every 6 hours thereafter*	MON-1S, MON-2S	vapor pressure
	ground water	30 min into test, 1 hr into test, 3 hrs into test, 6 hrs into test; every 6 hours thereafter*	ASI-1, ASI-2, MON-1D, MON-2D, MW-22	static water level (probe)
	extracted vapors	30 min into test, 1 hr into test, 3 hrs into test, 6 hrs into test; every 6 hours thereafter*	SVE-1	VOCs (Dräger tubes) air flow rate

Table 1. *Sampling and monitoring activities*

Phase	Media	Sample frequency	Location	Parameter (Method/instrument)
Phase 3: combined air sparging and soil vapor extraction test Test duration: 7 days	ground water	30 min into test, 1 hr into test, 3 hrs into test, 6 hrs into test; every 4 hours thereafter*	MON-1D, MON-2D, MW-22	DO (DO meter) static water level (probe)
	soil gas	30 min into test, 1 hr into test, 3 hrs into test, 6 hrs into test; every 4 hours thereafter*	MON-1S, MON-2S	VOCs (PID) vapor pressure
	air to AS well	30 min into test, 1 hr into test, 3 hrs into test, 6 hrs into test; every 4 hours thereafter*	ASI-1, ASI-2	air flow rate
	extracted vapors	30 min into test, 1 hr into test, 3 hrs into test, 6 hrs into test; every 4 hours thereafter*	SVE-1	VOCs (Dräger tubes)
Following pilot test	ground water	Once	MON-1D, MON-2D	VOCs (USEPA 8021) DO (DO meter) static water level (probe) helium (helium meter, air within wells)
	soil gas	Once	MON-1S, MON-2S	VOCs (PID) helium (helium meter)

Notes:
* Tests envisioned to be attended 10 - 12 hours daily, with monitoring only performed during attended hours.
MON-1S and MON-2S denote the monitoring points screened in the unsaturated zone.
MON-1D and MON-2D denote the monitoring points screened in saturated zone.
Dräger tubes for TCE and PCE.

Air Sparging Pilot Study Data

Date	3/23/99					3/24/99			3/25/99			3/26/99
Time	9:00	12:30	13:40	15:50	18:40	7:40	13:40	18:40	7:30	11:45	17:40	7:30
Flow (CFM)												
ASI-1	6	6	6	6	8	8	8	12	12	10	10	12
Helium Flow (% of air flow)												
ASI-1	0	4.9	1.8	3.2	0.65	0	0.59	--	0	1.1	--	--
Pressure (psi)												
ASI-1	0	3	3	3	2.5	2	2	2.6	1.25	1.25	--	2
Depth to GW (ft)												
MON-1D	15.94	15.77	15.89	15.94	15.94	15.94	15.94	15.56	15.95	15.95	15.95	15.96
MON-2D	16.22	16.03	16.2	16.26	16.24	16.25	16.26	15.96	16.24	16.22	16.14	16.15
MW-22	16.82	16.51	16.74	16.8	16.79	16.81	16.8	16.56	16.8	16.79	16.75	16.8
Dissolved Oxygen (mg/L)												
MON-1D	5.03	5.82	5.08	6.33	5.92	5.92	6.46	--	--	--	6.84	6.04
MON-2D	3.67	7.75	6.78	2.43	2.42	5.3	3.68	--	--	--	7.04	6.09
MW-22	1.92	4.69	4.42	4.01	2.51	1.65	1.13	--	--	--	2.04	2.2
VOCs (PID - ppm)												
MON-1S	1.5	4	3.5	4.4	11	10.7	3.4	1.9	7.3	4.4	5.7	5.6
MON-1D	1.2	0.9	0.2	0	4.2	1.5	0	0	1.6	0	0	1.7
MON-2S	6	31	13.7	17.3	31.5	34	26.2	31.4	23.2	13.2	25.1	35.6
MON-2D	0.6	0	0.3	0	3.1	4.7	0	6.6	66.7	25.9	2.6	3.4
MW-22	18.5	11.1	73.4	63.5	58.8	46.2	26.6	57.7	32.7	33.6	32.3	24.3
Helium (ppm)												
MON-1S	0	0	5.6	0.28	0	0	0	0	0	0	0	0
MON-1D	0	0	0.01	0	0	0	0	0	0	0	0	0
MON-2S	0	0	1	3	0.8	0	0.05	0	0	0.09	0.9	0
MON-2D	0	0	0	0	0	0	0	0	0	0	0	0
MW-22	0	0	7.1	0.63	0.61	0.03	1.1	0	0.44	0.52	0.35	1.5

Notes: Baseline data was collected on March 23, 1999 at 0900.
Phase I - AS test commenced on March 23, 1999 at approximately 1135.

Soil Vapor Extraction Pilot Study

Date	3/26/99					3/27/99			3/28/99		
Time	14:35	17:00	17:40	18:15	19:30	7:15	13:00	18:20	7:40	12:40	18:10
Depth to GW (ft)											
MON-1D	15.96	15.96	15.96	15.96	15.96	15.97	15.96	15.97	15.98	15.98	15.98
MON-2D	16.25	16.26	16.25	16.26	16.26	16.25	16.26	16.26	16.26	16.26	16.27
MW-22	16.83	16.83	16.83	16.83	16.84	16.84	16.85	16.85	16.85	16.85	16.86
ASI-1	16.92	16.91	16.91	16.91	16.91	16.91	16.91	16.91	16.91	16.92	16.92
ASI-2	16.79	16.8	16.8	16.79	16.8	16.8	16.8	16.8	16.8	16.81	16.81
Vapor Pressure (in. H_2O)											
MON-1S	0	0	0	0	0	0	0	0	0	0	0
MON-2S	0	0	0	-0.79	-0.79	-0.8	-2	-0.84	-0.8	-0.81	-0.76
Extracted Vapors											
(VOCs Draeger)											
SVE - 1 (ppm)											
TCE	--	--	0	0	0	0	0	0	0	0	0
PCE	--	--	0	10	5	2	5	2	2	2	1
Air Flow (CFM)	--	50	100	100	100	100	120	100	100	100	--

Notes: Baseline data was collected on March 26, 1999 at 1435.
Phase II - SVE test commenced on March 26, 1999 at approximately 1630.

Combined Air Sparging and Soil Vapor Extraction Pilot Study

Date	3/29/99						3/30/99				
Time	8:15	9:40	10:15	12:20	13:50	18:00	6:00	12:00	15:30	16:30	17:30
Water level (ft)											
MON-1D	15.99	16.06	15.97	15.98	16.01	15.99	16.01	16.02	16	16.02	16.03
MON-2D	16.28	16.37	16.27	16.25	16.29	16.27	16.31	16.3	16.28	16.3	16.32
MW-22	16.87	16.99	16.84	16.82	16.87	16.87	16.89	16.89	16.85	16.87	16.89
Dissolved Oxygen (mg/L)											
MON-1D	7.47	7.41	8.86	8.35	8	8.18	8.73	8.7	8.22	8.39	8.28
MON-2D	7.56	8.58	0.82	0.69	1.15	8.53	7.51	7.13	6.52	7.43	7.47
MW-22	0.97	3.32	2.92	1.55	1.8	1.85	1.86	1.77	1.64	1.91	2.39
Vapor Pressure (in. H_20)											
MON-1S	0	0.01	0.015	0.015	0.015	0.01	0.01	0.005	0.01	0.01	0.01
MON-2S	< 0	<0	< 0	< 0	< 0	0	<0	<0	<0	<0	<0
VOCs (PID - ppm)											
MON-1S	1.1	0	0	0	0	0	0	0	0	0	0
MON-2S	0	0	0	0	0	0	0	0	0	0	0
Air Flow Rates (CFM)											
ASI-1	6	6	6	6	6	6	6	6	10	10	10
ASI-2	6	6	6	6	6	6	6	6	6	6	6
Extracted Vapor											
SVE-1 (ppm)											
TCE		0	0	0	0	0	0	0	0	0	0
PCE		2	1	2	1	1	1	2	1	1	1

Combined Air Sparging and Soil Vapor Extraction Pilot Study

Date	3/31/99				4/1/99				4/2/99			
Time	6:00	10:00	14:00	18:00	6:00	10:00	14:00	18:00	6:00	10:00	14:00	18:00
Water level (ft)												
MON-1D	16.03	16.03	16.04	16.04	16.03	16.03	16.03	16.03	16.06	16.06	16.04	16.05
MON-2D	16.31	16.3	16.31	16.31	16.31	16.31	16.31	16.33	16.33	16.33	16.34	16.33
MW-22	16.88	16.89	16.9	16.9	16.9	16.9	16.91	16.92	16.91	16.91	16.93	16.93
Dissolved Oxygen (mg/L)												
MON-1D	8.27	8.33	8.3	8.09	8.17	8.21	8.28	8.26	8.11	8.27	8.48	8.24
MON-2D	7.47	8.18	6.92	7.3	7.56	7.22	7.4	7.32	7.66	7.88	7.88	7.74
MW-22	2.28	1.66	2.15	1.87	1.91	2.02	1.29	1.86	1.47	1.31	1.57	1.46
Vapor Pressure (in. H20)												
MON-1S	0.01	0.005	0.01	0.01	0.01	0.01	0.01	0.01	0.005	0.005	0.005	0.005
MON-2S	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0
VOCs (PID - ppm)												
MON-1S	0	0	2	3.9	3.2	2.7	--	--	--	1	0.2	1.2
MON-2S	0	0	0	0	0	0	0	--	--	0	0	0
Air Flow Rates (CFM)												
ASI-1	10	10	10	10	10	10	10	10	10	10	10	10
ASI-2	6	6	6	6	6	6	6	6	6	6	6	6
Extracted Vapor												
SVE-1 (ppm)												
TCE	0	0	0	0	0	0	0	0	0	0	0	0
PCE	1	2	1	2	2	2	1	2	1	1	1	1

Combined Air Sparging and Soil Vapor Extraction Pilot Study

Date	4/3/99				4/4/99				4/5/99
Time	6:00	10:00	14:00	18:00	6:00	10:00	14:00	18:00	6:00
Water level (ft)									
MON-1D	16.06	16.06	16.04	16.05	16.06	16.06	16.05	16.04	16.05
MON-2D	16.33	16.33	16.35	16.33	16.33	16.33	16.36	16.35	16.35
MW-22	16.93	16.93	16.95	16.92	16.93	16.93	16.95	16.95	16.95
Dissolved Oxygen (mg/L)									
MON-1D	8.08	8.37	8.3	7.63	8.31	7.54	8.26	8.18	8.31
MON-2D	7.41	7.71	7.58	7.34	6.93	6.63	7.76	7.51	7.61
MW-22	1.57	1.62	1.46	1.47	1.31	1.42	1.47	1.4	1.42
Vapor Pressure (in. H20)									
MON-1S	0.006	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
MON-2S	<0	<0	<0	<0	<0	<0	<0	<0	<0
VOCs (PID - ppm)									
MON-1S	1.2	1.6	0.8	1.4	1.2	1.2	0.6	0.6	0.6
MON-2S	0	0	0	0	0	0	0	0	0
Air Flow Rates (CFM)									
ASI-1	10	10	10	10	10	10	10	10	10
ASI-2	6	6	6	6	6	6	6	6	6
Extracted Vapor									
SVE-1 (ppm)									
TCE	0	0	0	0	0	--	--	--	--
PCE	1	1	1	2	2	--	--	--	--

Notes: Baseline data was collected on March 29, 1999 at approximately 0815.
Phase III - combined AS/SVE test commenced on March 29, 1999 at approximately 0900.

Formulas and limits

1. Calculation of lbs/hour emissions from SVE stack

$$\frac{lbs}{hr}\ compound = (x)\ (y)\ \frac{(8.2235x10^{-5})}{(T + 460)}\ MW$$

$$x = acfm\ air\ (\ velocity\ (ft/\mathrm{min})\ x\ area\ of\ discharge\ pipe\ (ft^2)\ )$$

$$y = ppmv\ compound$$

$$T = discharge\ temperature\ {}^\circ F$$

$$MW = molecular\ weight\ of\ compound$$

MW PCE: 165.85
MW TCE: 131.40
MW TCA: 133.42
MW DCA: 98.96
MW DCE: 96.94

2. Total VOC discharge maximum

5 lb/day maximum for TOTAL VOCs = 0.21 lbs/hr

To account for Dräger tube inaccuracy, SVE system should operate at maximum calculated total VOC emissions of 0.105 lb/hr.

3. Helium usage to be sufficient to be detectable with helium detection meter. Recommend at least 3% by volume. Only use helium during daily monitoring periods for air sparge test phase.